Space Weather Technical Forecast

Issued on Tuesday, 11 July 2023 at 13:06 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1/Minor Storm likely, chance of G2/Moderate Storm on 13 July with CME arrival. Chance of R1/R2 radio blackouts throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with a M1.4 flare peaking at 10/2218 UTC, originating from AR3366 in the southwest. Eleven active regions cover the visible solar disc. AR3361 in the northwest is the most magnetically complex region, with a delta spot. AR3363 in the southeast is the largest region, and presents as a large unipolar spot. AR3366, AR3368 and AR3369 are all close together in the southwest, with some magnetic interaction between these regions, probably increasing instability. AR3367 in the northwest is moderately large and continues to display reorganisation of the intermediate spots with little change in overall size and complexity. A new unnumbered region on the southeast limb appears unipolar and simple, and there is now the leading edge of a further moderately large spot showing at the northeast limb. The majority of the remaining regions appear small and simple.

A partial halo CME associated with the 10 July M2 flare was seen travelling towards the southwest in coronagraph imager and an Earth directed component is considered probable as detailed below.

Solar Wind / Geomagnetic Activity: The solar wind as observed at L1 by ACE/DSCOVR, was at slow- ambient levels throughout and solar winds varied between 315-330 km/s. The density was below average. Total magnetic field strength has been weak throughout, generally below 6 nT, whilst the north-south component also varied weakly. The phi angle has been steadfastly positive (away from the Sun). Geomagnetic activity has been at Quiet levels throughout (Kp 1-2), as observed by BGS.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, has been well below the S1/Minor Storm level, but is very slightly raised above the normal background as a result of recent M-class flares. High energy electron flux (greater than 2MeV), as observed by GOES16, was at mostly moderate levels, with a peak of 933 pfu at 10/1810 UTC. The 24-hour integrated fluence was below the Active (1e8 integrated pfu) threshold on a steady trend. A fluence of 4.05e7 pfu was recorded at 11/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate solar activity is most likely through the guidance period, with a slight chance of an isolated X-class flare.

Solar Wind / Geomagnetic Activity: A partial halo CME associated with the M2 flare at 10/0355 UTC was seen travelling towards the southwest in coronagraph imagery. An Earth directed shock component is considered probable. At this stage, an arrival time of around 13/0600 UTC is most likely, but confidence is rather low.

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The solar wind is currently slow-ambient and is likely to remain that way until the CME arrival. As the CME effects continue, a HSS from CH23/- is likely to arrive during Day 3 (13 July). The combination of CME effects and HSS could lead to increased geomagnetic impacts.

Geomagnetic activity is forecast to be Quiet at first, becoming Active to G1/Minor Storm (Kp4-5) with a chance of G2/Moderate Storm intervals (Kp6) due to CME and HSS effects on Day 3 (13 July), then probably returning to Unsettled (Kp3) by Day 4 (14 July).

Energetic Particles / Solar Radiation: The high energy (greater than 10MeV) proton flux has a slight chance of reaching the S1/Minor Storm threshold through the period, should any larger flares occur. High energy electron flux (greater than 2MeV) is likely to reach moderate levels at first, with a sharp decline anticipated during Day 3 (13 July) as the anticipated CME arrives. Electron fluence is expected to remain below the Active threshold (1e8 integrated pfu), before dropping during Days 3-4 with the CME and HSS arrivals.

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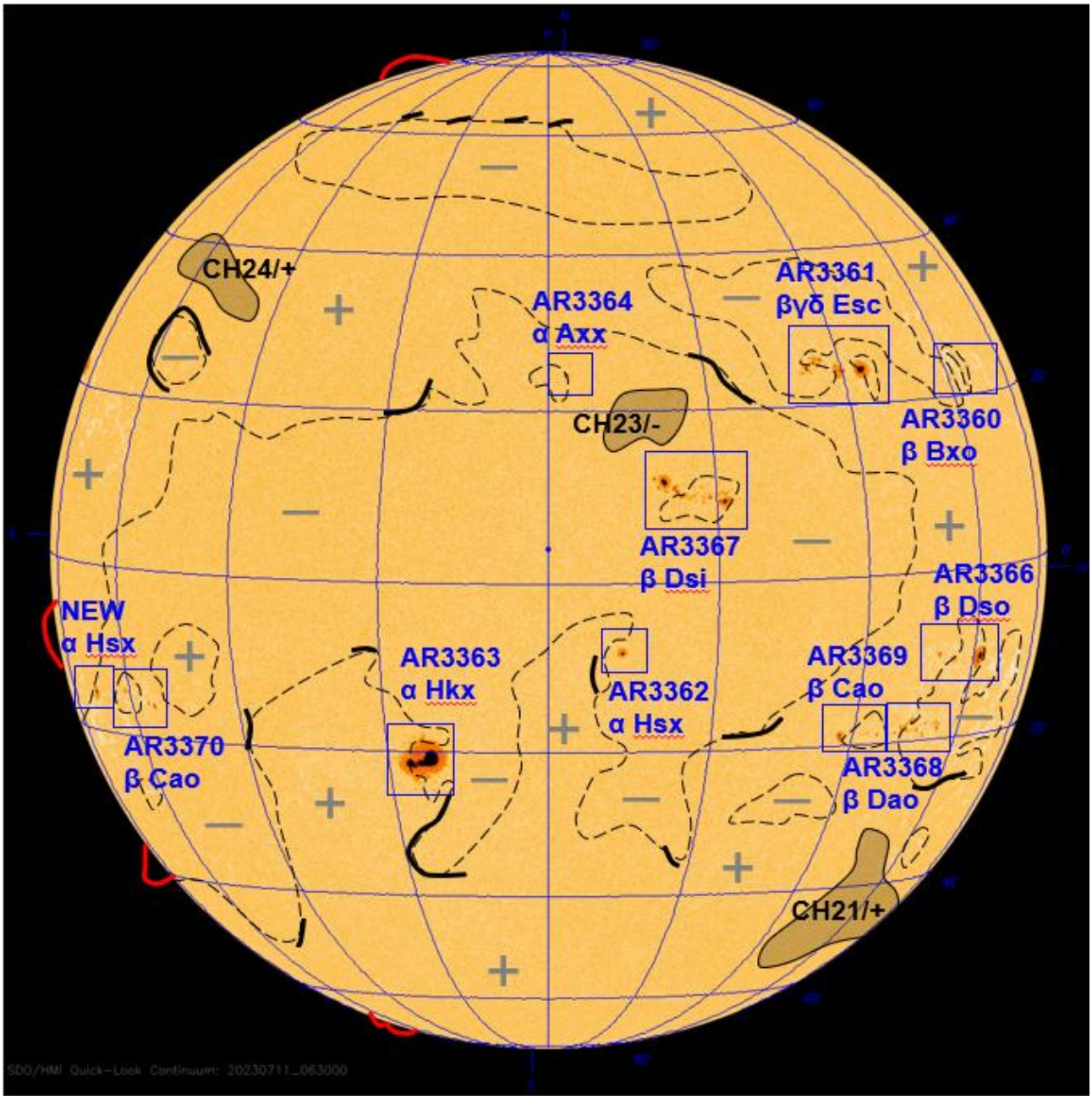
Figure 1. Solar Analysis Valid 11/0700UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A partial halo CME associated with the M2 flare at 10/0355 UTC was seen travelling towards the southwest in coronagraph imagery. There was also a fainter asymmetric full halo from the shock. Although the bulk of the CME is expected to pass ahead of Earth, an Earth directed shock component is considered probable. At this stage, an arrival time of around 13/0600 UTC is most likely, but confidence is rather low.

The solar wind is slow-ambient and is likely to remain that way until the CME arrival. As the CME effects continue, a HSS from CH23/- is likely to arrive during Day 3 (13 July). On the previous rotation this feature resulted in solar winds reaching 600-700 km/s, and a maximum geomagnetic response of G2/Moderate storm. On this rotation the feature appears smaller and more fragmented in appearance, and this will probably lead to lower solar wind levels and associated impacts. However, the combination of CME effects and HSS could lead to increased geomagnetic impacts.

Geomagnetic activity is forecast to be Quiet (Kp 0-2) at first, becoming Active to G1/Minor Storm (Kp 4-5) with a small chance of G2/Moderate Storm intervals (Kp 6) due to CME and HSS effects on Day 3 (13 July). Thereafter a decrease in activity is most probable with geomagnetic activity returning to Unsettled levels (Kp 3) on Day 4 (14 July).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	10	30	20
Strong	G3	No	1	1	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
10/1107	Partial Halo	AR3366	SW	900 km/s	13/0600UTC	Limited shock expected. Rather low confidence for CME arrival.

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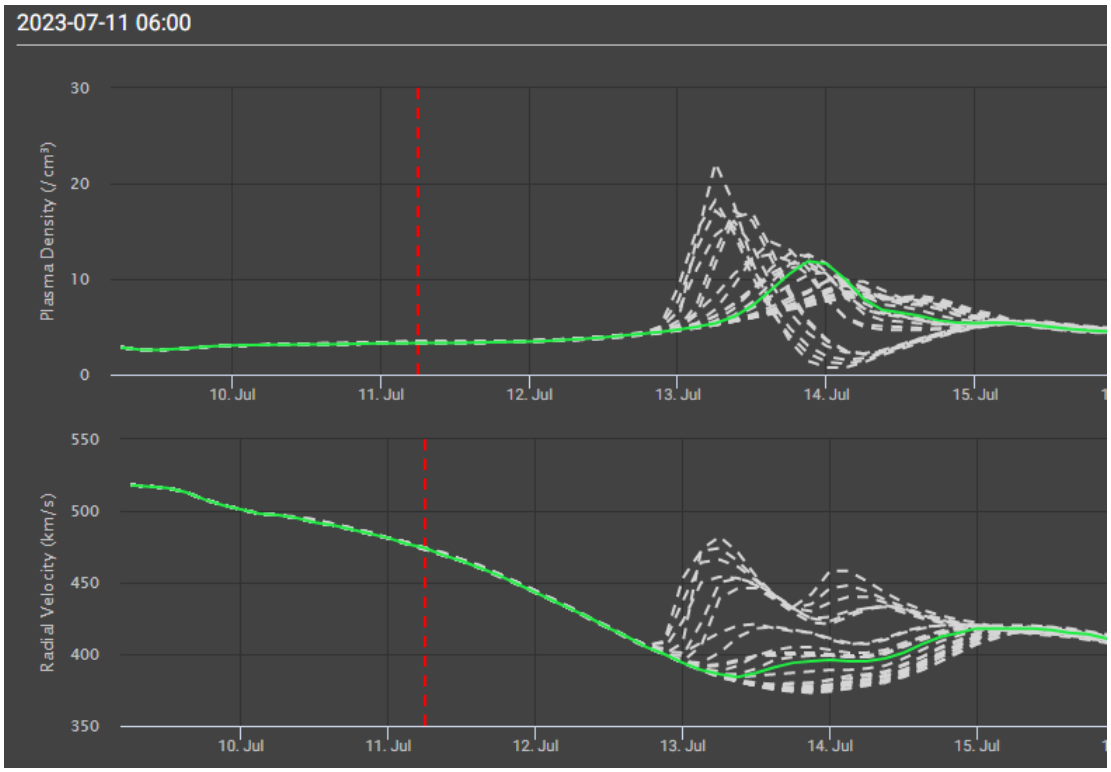
Figure 2: MOSWOC Enlil Ensemble showing potential arrival times for CME on 13 July.



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Radio Blackouts - X-Ray Flares:

Solar activity has been Moderate, with a M1.4 flare peaking at 10/2218 UTC, originating from AR3366 in the southwest. Low to moderate activity is likely to continue, with a slight chance of an isolated X-class flare.

Eleven active regions cover the visible solar disc. AR3361 in the northwest is the most magnetically complex region, with a delta spot. AR3363 in the southeast is the largest region, and presents as a large unipolar spot. AR3366, AR3368 and AR3369 are all close together in the southwest, with some magnetic interaction between these regions, probably increasing instability. AR3367 in the northwest is moderately large and continues to display reorganisation of the intermediate spots with little change in overall size and complexity. A new unnumbered region on the southeast limb appears unipolar and simple, and there is now the leading edge of a further moderately large spot showing at the northeast limb. The majority of the remaining regions appear small and simple.

No major active region is forecast to depart the visible disc during the period and far side sounding data suggests that further regions may rotate onto the disc during the coming days.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is currently near background levels, although recently very slightly raised in the wake of the M2 flare early on 10 July. There is a slight chance of S1/Minor or greater storm levels being reached through this period, should any larger flares occur mainly from regions in the western hemisphere, and perhaps most likely from AR3366 which appears to be more favourable for this activity.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) at GEO has been at largely moderate levels in recent days. The BAS radiation belt model suggests only a limited increase in electron flux has taken place below GEO, probably due to a recent HSS. Electron flux is now considered most likely to continue to reach moderate levels over the next couple of days. The expected arrival of a CME on Day 3 (13 July), soon followed or accompanied by a HSS is expected to give a sharp decrease in flux during the second half of the period.

Electron fluence continues to remain on a broadly level trend below Active levels (1e8 integrated pfu). This is likely to remain similar, perhaps with a further slight rise possible through Days 1 and 2 (11-12 July), before a drop off on Days 3-4 as the CME and HSS arrive. MOSWOC REFM guidance is showing a steady trend below Active, which is considered to be giving sensible guidance although it won't be taking account of the likely CME arrival.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	20	10	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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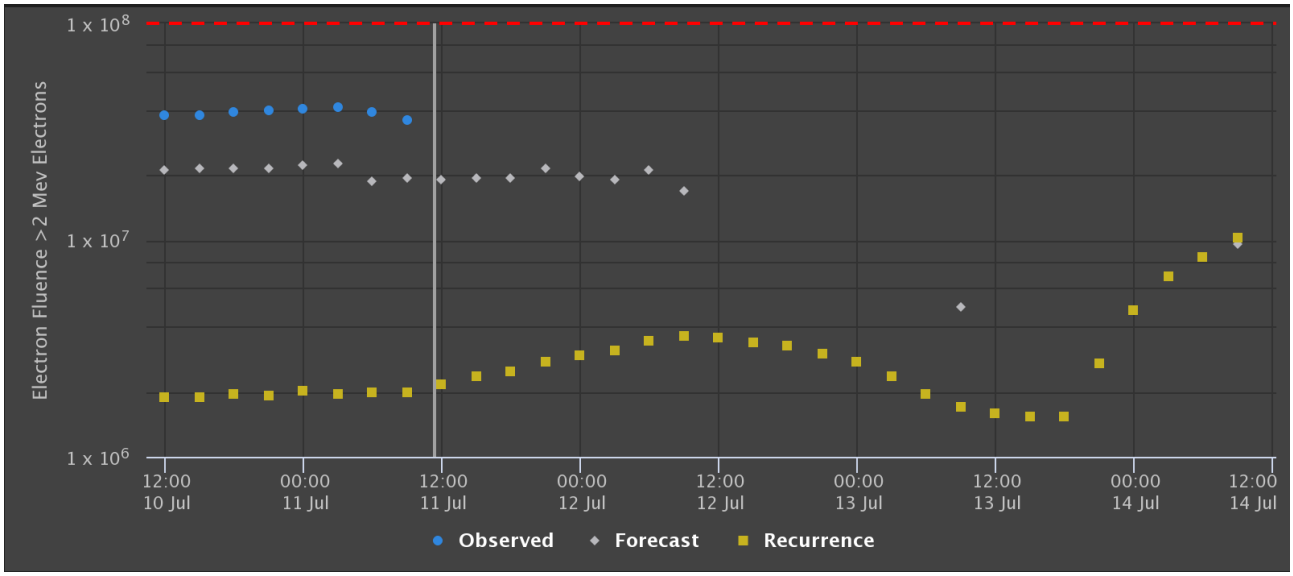
Figure 3: MOSWOC REFM output.



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